CHINA'S UNIVERSITY GRADUATION PROJECTS FOR DEVELOPING ADVANCED TECHNOLOGY

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- Principally Concerning Research in Program-Controlled Machine Tools and Strength of Machine Metal Materials -

In 1958, the Central Committee of the Chinese Communist Party clearly set forth the policy of "making education serve proletarian government and linking education and production labor," and this policy is firmly carried out in China's university education and gradually seems to be gaining sound results. This policy is also carried out in the educational system of working and studying expressed recently by such words as "half work and half reading" and "half agriculture and half reading," and in the case of regular university education, it often appears as the graduation project. These graduation projects are expressed in China as "real sword and real spear" graduation projects, which has the meaning of "fighting with real swords," and university students who have not yet graduated join up with plants and other production units which have the same respective specialties and fields, and deeply entering on-the-spot into these production units and seizing a technical problem point in production, they make solution of this the theme of a graduation project. This was started by various universities in 1958 when the above-mentioned educational policy of the Chinese Communist Party was put forth, and this policy, together with supplying young technicians to various production units which have the necessity of solving technical problems pressing upon them from the point of view of production, is also considered to be "an effective method for breaking through the foreign framework, training students in practices of the production struggle and scientific experimentation, and quickly bringing about growth."

From 5 to 12 October of last year, a graduation projects operation meeting was held at Sian Chiaotung University in which more than 60 department heads and professors of ten engineering universities directly under the Higher Education Department participated, and according to points agreed upon by these participants, new development in 1965 was seen in graduation projects (including graduation theses) operations of engineering universities directly under the Higher Education Department, and most students had conducted graduation projects linked to actual tasks of production construction or scientific research. These ten schools last year had 16,000 graduates, and more than 15,000 had graduation projects, which was more than 95 percent of the total number of graduates, and there were more than 4,000 graduation project subjects combined with actual tasks, which was more than 95 percent of the total number of subjects. Subjects of these more than 4,000 graduation projects combined with actual tasks are roughly half items which have already been started in production or have been adopted in production departments and scientific research units, and some of the items are gradually gaining results. Taking Dairen Engineering College as an example, of the 364 graduation project subjects of last year, 160 have already entered into production and 108 have been adopted by production departments.

That such student graduation projects are in large number being directly adopted in production is in itself a characteristic differing from Japan and is very noteworthy, and it should also be mentioned that some of the items of the various schools have surmounted technical obstacles and reached a very high stardard, and top-level projects and research are being conducted which will boost China's science and industrial technology to a new level. Seen in this way, this trend in university education can be said to stir an interest which cannot be disregarded by those who have interest in China's industrial and scientific technology.

For example, according to the above-mentioned conference, in last year's graduation projects, professors and students of Huachung Engineering College, in cooperation with the Wuhan Diesel Engine Plant, jointly designed China's first movable air-cooled diesel engine and succeeded in its trial-manufacture. Professors and students of the Huatung Chemical Engineering College, in cooperation with a plant, reformed China's sugar-refining process, and solved such problems as that there were many manufacturing processes, the taste was sharp and the granules were small. Also, professors and students of Huanan Engineering College designed a passenger and freight ferryboat to be placed in service in the Hainan Straits, and this is said to have definite significance in development of Hainan Island. The stageless variable speed elevator which was studied and trial-manufactured by professors and students of Tientsin University reached an advanced level, and one is already in use in the Peking Civilian Navigation Bureau Building. Professors and students of the Insulation Department of Sian Chiaotung University participated in trial-manufacture at the Sian Condenser Plant of chlorophenyl benzene condenser insulation oil and reduced the loss of induced electricity in domestically-made

trichlorophenyl benzene, and this is considered to have important significance in raising the level of China's condenser production. Also, the machine traction harrow which professors and students of Chekiang University successfully studied and which used white cast iron of high pliability instead of manganese steel, has a life three times as long, and the cost is only one fifth that of manganese steel. Professors and students of the Nanking Engineering College, in cooperation with the Shanghai Electron Tube Plant, successfully trial-manufactured a low-base discharge computation tube and accomplished standardization of the product.

The above are but examples of the level of such graduation projects, and since according to Chinese newspaper reports many graduation projects besides these which should be noted have been conducted, below we shall look at ones among them which may be considered to be especially important.

Chinghua University Which Is Obtaining Numerous Results

One of the universities which is obtaining especially outstanding results in graduation projects is Chinghua University in Peking. Since 1958 this university has adhered to the course of graduation projects which are truly of use to production, and all of last year's graduates conducted graduation projects linked to actual production tasks and scientific research, and obtained great results. According to approximate statistics, the 2,000 students who graduated last year, under guidance and assistance of instructors, joined several tens of related units outside the university and completed more than 150 actual task items. Among these, a considerable part of the themes are considered to have a quite high scientific and technical level or quite great national economic significance. Research into several items among them of a comparatively large scale was begun several years ago and finished by being "relayed" to successive graduation projects. In addition, more than 70 items have not yet been completed but have generally obtained results. Graduation project items of Chinghua University can be generally divided into three kinds.

The first kind is trial-manufacture of new products. For example, the several kinds of automated machine tools controlled by an electronic computer trial-manufactured by the Precision Measuring Instruments and and Machine Construction Department and the Electricity Department in collaboration with related departments of the Peking No. 1 Machine Plant and the Peking No. 3 Machine Plant and others, can directly process machine parts of complicated form and very high precision without using die plates. Also, the titanium evaporation ion pump (titanium diffusion pump) trial-manufactured by the Telegraph and Electronics Department with the Chinese Academy of Sciences Scientific Instruments Plant is important equipment for large-sized electron tubes which manufacture high vacuums, and can make the degree of vacuum 10^{-9}mmHg (in such a high vacuum, gaseous elements are only contained to the extent of 1/760,000,000,000 of ordinary air). It is said that several which were trial-manufactured have already begun to be used and soon will enter

into quantity production.

The second kind is technical innovation. Many students have deeply entered into related plants and assisted in solving some technological problem point in production. For example, instructors of a physics instructors' research group, leading students of the Manufacturing Processes Physics Department, joined with a certain iron and steel plant, and using radioactive isotypes, conducted an automatic control operation of the hot metal fluid level of steel ingot continuous casting, increasing the formation rate and quality of steel ingots and improving working conditions for the workers. Also, instructors and students of the Metallurgy Department, in connection with graduation projects and in cooperation with the Loyang No. 1 Tractor Plant, solved a problem of the surface quality of cast-metal parts. With previous cast-metal parts of the Loyang No. 1 Tractor Plant, sand would stick and pustules often formed, and for this reason, not only was the rate of waste articles high and longevity short, but it also affected the attractiveness of the tractors, and the instructors and students, in cooperation with factory personnel, conducted 1,000 experiments, and the phenomenon of waste articles arising because of infericrity of the surface of cast-metal parts was almost eliminated, quality was remarkably improved, and cost lowered.

The third kind is special problem experimentation and research. In the process of trial-manufacture and technical innovation of products, special problems which have a ubiquitous significance are often presented, such as loss of electricity, quality of welding, and dam stress. Solution of these special problems which arise in production has a certain investigative nature and requires quite penetrating research, experimentation, and analysis. Completion of these tasks increases by a step understanding of certain kinds of objective laws and provides data for basically solving production problems.

Chinghua University's Program-Controlled Machine Tools

Among the above kind of Chinghua University graduation project results, numerical value program-controlled machine tools controlled by calculation-type electronic computers, together with being production tools urgently needed at present in China's state construction, are considered to show an important course in development of machine tools.

For example, in manufacturing one airplane, first constructing from several tens of thousands to more than a hundred thousand die plates, processing must be advanced on the basis of the form of these die plates. The form of these die plates is very complicated and precision requirements are very high, and according to foreign data records, a step-by-step production preparation period of one to two years is considered necessary. However, when program-controlled machine tools are used, without using die plates, products of various kinds of complicated form can be directly processed, and production efficiency and processing precision are greatly increased. Consequently, in the last few years, development of this kind of machine tool has also been very fast internationally.

Research and construction of these program-controlled machine tools was begun at Chinghua University in 1958. At first, there was intense debate as to whether or not this kind of research and construction was necessary. However, instructors and students of such departments as machinery and electrical machinery thought that not only was there an immediate requirement of state industry for program-controlled machine tools, but that an overall industrial college such as Chinghua University had the conditions for expanding research and construction in this field. Thus, adhering to consolidation of education, scientific research, and production, and cooperating with the Peking No. 1 Machine Plant, in a period of three months they trial-manufactured two different conduction-type program-controlled milling machines and in the following year, again cooperating with a different plant, trial-manufactured one program-controlled drilling machine.

Of course, newly-produced items are always immature, and these machines also had to constantly be improved. Whereas on the one hand they process-tested one of the program-controlled milling machines for a long period in a related plant, on the other program-controlled milling machine, they conducted systematic experimental research and improvement on efficiency and structure of key parts and accessories. Stability of previous electronic computers was inadequate and they often had strange "nervous disorders," and working night and day shifts for several months, they examined the various phenomena disclosed in continuous operation, and finally their laws were ferreted out and stability greatly increased. On this basis, a new electronic computer was designed and manufactured, and with regulation over a short period of time, it became possible to conduct stable operation many times for more than 56 hours continuously. They also conducted several thousands of experiments concerning such parts as drilling guide screws and increased the precision of this milling machine above original design standards. At the same time, the Peking No. 3 Machine Plant, in cooperation with the Peking Electrical Machinery Burea Design Company, successfully trial-manufactured a transistor computer and attained transistorization of a program-controlled milling machine. When this transistor computer, of which the weight and volume are not much different from a six-tube radio, replaced the former electronic computer, the life increased 11 times, electricity consumption did not even reach one percent of that previously, and it was also possible to considerably lower costs.

At present, these three program-controlled machine tools as well as their control systems have gone through rigorous examination over a quite long period of time, and also, appraisal was advanced by means of an appraisal committee formed by 15 units such as related leadership organs, research institutes, and plants, and it was proved that the control systems of the machines are stable and can be adequately relied upon, and that precision of model processed items meets design requirements, and it has been recognized by many people that the performance of these several machine tools can satisfy processing requirements of many processed items and that if appropriate improvements are added, they can be made product samples. And manufacture of product

samples of program-controlled milling machines and program-controlled drilling machines has already begun in related departments, and preparations for going into production are being advanced.

At Chinghua University, with seven years of research into program-controlled machine tools, a program-controlled machine tool laboratory was established and a group of talented people trained, creating conditions for greater expedition of future research in this field and also for increasing the quality of education. Since 1958, successive graduates of related sections of the Machinery and Electric Machinery Departments have reached more than 300, and they have advanced graduation projects linked with this research work and have received useful on-the-spot training, and also, more than 20 research students have written graduation theses concerning this research. Instructors and students have altogether written 72 scientific essays and technical reports, and of these, 14 were read at all-country scientific conferences.

Research of Sian Chiaotung University into Strength of Machine Metals

Aside from the above research results of Chinghua University which should be especially mentioned, there is no end to up-to-date research results which can be enumerated such as the research result of teachers and students extending over eight years which showed that granite of the South China region which had for the past more than 40 years been thought to have been formed in the same geological age, was not formed in the same geological age, which made possible scientific prediction of various kinds of mining products prospecting, the graduation project of five of the first graduates of the workers squad of the Shanghai Scientific and Technological University who successfully designed and manufactured China's first high-precision cycle variable power supply, and the Dairen Engineering College design of the Dairen fishing port which has already been started and will soon be completed, but here we will put the spotlight on another, - research results of Sian Chiaotung University which produced new theories concerning strength of metal materials.

Theoretical research results of Sian Chiaotung University concerning strength of metal materials has already begun to play a role in China's machine industry production. The great significance of this theoretical research is considered to be that it has given a scientific basis for rational selection of materials by the machine-manufacturing industry and has manifested latent strength of modern metal materials.

For many years the thought prevailed in machinery construction circles that in assuring stability of the operating time of engine parts it was necessary to use materials of high "shock toughness." Thus, in determining fluctuations of "shock toughness," the method was used of "bestowing one shock with a large-energy pendulum," and if the energy expended in destruction was low, it was considered that material could not be adopted. Thus, many high-strength materials were not used simply for the reason that their "shock toughness" was low, and moreover, since "toughness" was blindly pursued, they could not but be changed

into low-strength materials, and for this reason, dimensions of engine parts became large, designed parts were heavy and large, and there was waste of metal materials. This was one of the universal problems in machine industry production.

In this regard, in 1958 Professor Chou Hui-chiu, head of the Sian Chiaotung University Machine Department and also head of the laboratory, knowing that the life of well-drilling machine pistons made by a certain factory with brittle materials was twice as great as first-rate nickel chrome cement steel and calling to mind many similar facts of the past, thought it would be greatly significant in China socialist construction if this quite important problem in the machine industry could be solved. Thereupon, he won the support of management and began this research. At first, some persons expressed doubts, and conditions were rather bad and there were many difficulties, but they did not become discouraged. Since there was no testing machine, they themselves designed and built one using scrap material. Thereupon, this research was regarded seriously by related leadership, and establishing a specialized research organization, systematic research in the various fields of strength of metal materials was suddenly begun.

Bringing Forth the Theory of Small-Energy Multiple-Shock Resistance

Research results of the Sian Chiaotung University metal products strength laboratory showed that under ordinary circumstances, shocks received by various kinds of machine parts occur continuously and that the shock energy is ordinarily comparatively low. Under such circumstances, the resistance power to destruction of materials is generally determined by strength, and comparatively little plasticity and "shock toughness" is necessary. Eventually it was shown that latent strength of many high-strength materials which had previously been rejected by single-shock experiments with the large-energy pendulum could be manifested if they were rationally used.

For example, research made clear that whereas previously, high-temperature tempering had been necessary when machine parts were made with medium carbon steel, the tempering temperature could now be greatly reduced, and also, whereas previously it had been required that the carbon content of the core of cement steel generally be lowered to from 0.1 to 0.18 percent, under conditions of small-energy multiple-shock, it was more advantageous if the carbon content were increased to 0.25 to 0.30 percent. They also found that the small-energy multiple-shock resistance of spherical graphite cast iron was superior to medium carbon steel, providing a theoretical base for wide use of spherical graphite cast iron. In past practice it had been thought that low carbon steel could not be strengthened by tempering, but in their research it was shown that low carbon steel could be strengthened by tempering and made into low carbon martensite and that moreover it has excellent overall strength properties suitable for machine manufacture. In addition, they also systematically studied such things as plasticity, fatigue strength, and overload damage susceptibility of various high-strength materials, and thoroughly demonstrated the possibility and rationality of being

able to manifest latent strength of metal materials.

These theoretical research results have already begun to be applied in machine industry production and are producing rudimentary results. The same school, together with the Shanghai Petroleum Machinery Accessories Plant, changed the material and heat-treatment method of 01-03 oil rock drill pistons, and with on-the-spot experimentation with the hardest rocks of a certain copper ore, useful life was increased by from two to three times. At the Changchun No. 1 Automobile Manufacturing Plant, through cooperation of schools with the plant, materials and heat treatment of three kinds of automobile parts have already been changed and formally entered into production, and among them, the "terminal decelerator pinion washer" which was previously manufactured with specially-made excellent no. 45 medium carbon steel plate has now been changed to being manufactured with 16 manganese steel chassis frame cutting scrap, and at the beginning of last year more than 3,000 were produced, and by production practice it was demonstrated that quality requirements could be met and that about 10 tons of specially-made excellent steel plate could be economized. Also, the rivet snap which is used in rivetting is a typical part which receives a multiple-shock load, and the same school, in cooperation with the Sian Vehicle Plant, used as raw material outer rings which had been waste articles, improved the heat-treatment method, and greatly increased the useful life of rivet snaps. In initial production experiments it was shown that whereas previously only 200 rivets could be rivetted on an average with one rivet snap, now 3,200 could be rivetted, and that the cost of material was thus reduced to one tenth.

These theoretical results have already been applied by some production, education, and research units, and several actual problems have been solved. Examples of this are that the Loyang Agricultural Machinery College in cooperation with the Loyang No. 1 Tractor Plant studied strength characteristics and heat-treatment methods of engine cone rod bolts from the point of view of multiple-shock resistance and produced a new method of tempering medium carbon steel, and the Tsinan Shaping Tool Plant and Shantung Engineering College succeeded in research for manufacturing shovels with ordinary carbon steel, and at the Peking Petroleum College they manufactured an oil-well drilling hole-making gun, which had previously been made with high-grade alloy gun barrel steel, using low carbon martensite tempered from ordinary low carbon alloy steel, greatly increasing its useful life.

This theoretical research activity at Sian Chiaotung University has also excercised many propulsive effects in the field of education. Since 1959 more than 160 successive graduates specializing in metals and heat treatment in the Machinery Department have participated in this activity and have written more than 100 graduation theses. Twenty to thirty teachers specializing in this have successively participated in this activity and at present, aside from the more than 20 full-time researchers in the laboratory, twelve instructors of the metal instruction laboratory are engaged here in scientific research. These full-time and part-time researchers have altogether written several tens of theses.

RECENT NEW PRODUCTS OF THE CHINESE PRECISION MACHINE INDUSTRY - ELECTRONIC COMPUTER, ELECTRONIC MICROSCOPE, AND OTHERS -

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In China at present, a great technical revolution movement is being unfolded, mobilizing all workers and technicians. This movement is "being advanced with the objectives of developing new products, applying as widely as possible new techniques and latest scientific discoveries, and step-by-step semi-mechanization, mechanization, semi-automation, and automation" (New China News Agency dispatch, 27 September 1965), and its scope extends widely from small changes in work processes to development of new materials, new equipment, new technology, and new work processes, and from changes in individual design to technical reorganization of entire plants.

In this great technical revolution movement, energy has been especially devoted for the last several years in the Chinese machine industry to development of large-sized precision machines, which had previously been nonexistent, and with the policy of quickly catching up to the world level, amidst poor technical resources they are displaying the spirit of self-salvation and are striving whole-heartedly. And, this effort is continuously blossoming and bearing fruit.

In considering precision machines, this year alone a large number of precision machines and tools which had not previously been manufactured in China have been successfully trial-manufactured and entered into quantity production, including a 24-stage medium-sized electronic computer, a large-sized electronic microscope with a magnifying power of 200,000 and a resolving power of 7 angstroms, a high-precision measuring device which can measure errors of 5/100,000 mm., a large-sized X-ray flaw detector for industrial use, a new-model supersonic thickness measurer, a transistor supersonic rail flaw detector, a mechanical process-controlled automatic carbon

measuring device which analyzes carbon content of iron and steel, a transistor nuclear propelled type magnetometer used in prospecting, a precision micro-scale which has a minimum weight sensitivity of 1/1,000,000 gram, a photoelectrically controlled automatic material mixing scale, a traction measuring instrument, a radio altimeter and radio orientation meter for aerial measurements, a high-temperature water surface meter used in observation of water surfaces and oil, an electronic clock corrector, a solar telescope, and an electromagnetic oscillation tester. As a result of inspection, these precision machines and tools have all been proved to be of good efficiency, and there are many which surpass previously imported products and are not inferior to the internationally advanced level. Also, such things as the electronic computer and electronic microscope were displayed at the Chinese Economic Construction Exhibition in Rumania (September-October 1965) and the Chinese Measuring Instruments Exhibition in Cairo (September 25 to 4 October 1965), and were favorably received. For example, Minister of Scientific Research Tourky and Minister of Education Yusif of the United Arab Republic wrote in the record of impressions, "This exhibition shows China's great advance in the field of manufacture of measuring instruments."

Below, we would like to introduce new precision machine and tool products recently reported, as reference for becoming acquainted with part of China's precision machine industry.

Electronic Computer

A 24-stage medium-sized analog electronic computer was recently successfully trial-manufactured at the Tientsin Electronic Equipment Plant (Chungkuo Hsinwen, 8 June 1965). As a result of appraisal by the related department, its principal performance conformed to standards of the original design and initiation of production as a type model was authorized. Analog electronic computers were originally a blank spot in China, but following successful trial-manufacture at the Tientsin Electronic Equipment Plant in the summer of 1963 of an analog electronic computer and in 1964 of the FM-8 analog electronic computer (the performance of this FM-8 analog electronic computer reaches the international level of the same model product and it has already entered into quantity production), a 24-stage medium-sized analog electronic computer was recently successfully trial-manufactured. This electronic computer is a multi-shelf type and consists of such calculators as adding machines, multiplying machines, squaring machines, function development machines, and changed coefficient machines, and it can calculate 24-stage linear as well as non-linear differential equations, and when operators set up the program and a switch is turned on, in from a few seconds to a few minutes solutions are obtained, making calculations which could with difficulty be completed by several tens of persons in several months. In addition to being used as a computing tool, this computer can be used for such things as control, design, and analysis related to industry and national defense.

The Tientsin Electronic Equipment Plant was formed in 1958 from a combination of about 10 handicraft cooperatives and small plants and at first could manufacture only a few electrical products such as electric irons, but the same plant, by means of ardent self-effort and self-salvation has in the last few years already successfully trial-manufactured and produced more than 30 comparatively high-grade precision products, and has played a great role in filling up blanks in the field of China's electronic measuring instruments.

Production of electronic computers in China was initiated in July 1956 by a preparatory committee of the Computation Technology Research Institute of the Chinese Academy of Sciences, and trial-manufacture was first started in the following year of 1957, and in 1958, analog and digital electronic computers were trial-manufactured at some plants, universities, and research institutes, and also, trial-manufacture and research of numerical value controlled machine tools was begun by some universities.

In 1958, Shanghai's Electromagnetic Equipment Plant successfully trial-manufactured a large-sized analog electronic computer, and also, in the same year, the first domestically-produced small-sized digital electronic computer "81 Digital Electronic Computer" was trial-manufactured. In this small-sized digital electronic computer are used 4,000 germanium diodes and 800 electronic tubes.

The automatic control section of Chinghua University (Peking) has also succeeded in trial-manufacture of a high-speed general-use digital electronic computer which can make 10,000 computations each second and an automatic search-type analog electronic computer.

Accompanying successful trial-manufacture of electronic computers seen above, their sphere of application has gradually broadened. Digital computers have been used in China for the last several years in making a large quantity of computations and solving many problems in design of various kinds of construction works, design of many complicated machines and electrical machine products, in land surveying, and in research in such things as dynamics, atomic power, physics, chemistry, astronomy, and biology.

For example, in the field of weather forecasting, electronic computers have been used widely in short-term weather numerical value forecasting since the winter of 1960. The high-speed digital electronic computer installed at the Computation Tedhnology Research Institute is used in computations for this weather forecasting. When the meteorologists operate the computer on the basis of high-altitude weather charts, results are obtained in less than an hour. On the basis of these results, the weather situation of the entire country can be obtained within 48 hours. Electronic computers are also used in forecasting trends in rainfall and temperature for each month and each year.

At the Shanghai Astronomical Observatory, since they have come to measure standard time with the electronic computer which was manufactured in 1958 by the Huatung Computation Technology Research Institute, the calculation speed has increased as compared with before, and time reports have become more accurate. Also, at present, precision measurement of standard time measured by China's time-reporting

seven angstroms, which can be manufactured in only a few technically advanced countries.

This large-sized electronic microscope was successfully developed by the Shanghai Electronic Optical Research Institute, and it was designed through cooperation of Chinese scientists, technicians, and workers, and was manufactured completely using domestically-produced materials. At a recent all-country conference held in Shanghai, specialists, professors, and technicians from various cities who participated expressed great satisfaction with the completion, blueprints, and technical data of this new electronic microscope by means of severe tests.

Manufacture of an electronic microscope was initiated at the Shanghai Electronic Optical Research Institute in 1959, and in a period of three years, it became possible to manufacture an electronic microscope with a resolving power of 30 angstroms, and subsequently, after more than two years of endeavor, an electronic microscope with a resolving power of more than 20 angstroms and a magnifying power of 200,000 was manufactured, and after eight months of further endeavor, an electronic microscope with a magnifying power of 200,000 and a resolving power of seven angstroms was successfully manufactured. This electronic microscope consists of more than 10,000 parts, and new products of modern scientific fields have been introduced, such as an electronic lens, precision machinery, precision metallurgy, radio electronic engineering, ultrahigh voltage, and ultrahigh vacuum.

As was stated at the outset, at the time of the old China, even ordinary optical microscopes had to be imported, but at present, tool microscopes, metal microscopes, microscopes for medical use, microscopes for biology, and polarization microscopes are manufactured, and an infrared microscope which requires a high level of technology is also manufactured.

High-Precision Measuring Instrument

At the Dairen Barometer Company, a high-precision measuring instrument used in precision measurements of items processed by the machine industry is produced in quantity. This was designed and successfully trial-manufacured by professors and students of the Dairen Engineering College, and in conformity with air pressing upon a column of mercury, causing it to go up and down, it measures such things as precision-processed linear dimensions, surface texture, small holes, and airtightness. If a separate head or accessories are attached, it can also measure the precision of round shapes, round holes, and various forms of processed materials. With a micrometer can be measured only 1/100 mm., but this high-precision measuring instrument can measure an error of 5/100,000 mm (New China News Agency, 6 September 1965).

Large-Sized X-Ray Flaw Detector for Industrial Use

system has an error of less than 2/1000 second, and has reached the international advanced level.

Electronic computers are also used in the field of commodity transportation. In April 1963, an all-country nitrogenous fertilizer delivery plan was formulated on the basis of numerical values of electronic computers, and it was possible to save more than 2,600 tons of tranported amount above the plan formulated on the basis of experience.

Research into numerical value controlled machine tools controlled through use of digital electronic computers has also been advanced since 1958 at Chinghua University, and the principal efficiency of trial-manufactured products has reached a quite high level. In related departments, at the end of 1964, manufacture of product samples of a program-controlled milling machine and a program-controlled drilling machine was begun, and preparations for initiation of production are being advanced. By the appraisal in July of this year of the appraisal committee formed by 15 units of related leadership organs, research institutes, and plants, it was proved that the control system of the machine is stable and fully reliable, and that precision of model processed items fulfills design requirements.

Also, automatic control equipment, remote control measuring equipment, electronic computers, "SZ-1 figure tubes" which are an important part of computer-type measuring instruments, and iron, chrome, and aluminum electric resistance parts used in remote control and remote measurement, have recently been successfully manufactured.

The "SZ-1 figure tube" was successfully trial-manufactured at the Shanghai Electronic Tubes Plant, and it shows Arabic numerals from 1 to 0, and when several of the same tubes are placed side by side, figures of 1, 10, 100... can be brought forth in the indicator portion of the computer, and it can be directly read in figures at the time of measurement. After strict examination, it was proved that the sensitivity and accuracy of this figure-showing tube are very high and that moreover its useful life is long. It has already entered into small-quantity production (New China News Agency, 12 September 1965).

Next, iron, chrome, and aluminum electronic resistance parts were successfully trial-manufactured at the Peking Steel Thread Plant, and these parts which are thin and can hardly be seen with the naked eye are used in such precision equipment as measuring instruments, medical equipment, and radio communication equipment, and accurately reflect faint motions and various wave forms which people wish to know. This precision product is at present produced in only a very few countries of the world (New China News Agency, 15 September 1965).

Electronic Microscope

At the time of the old China, even ordinary optical microscopes had to be imported, but after establishment of the new China, microscope engineering developed rapidly, and recently, they have come to be able to manufacture a large-sized high-efficiency electronic microscope with a magnifying power of 200,000 and a resolving power of

China's first domestically-produced large-sized X-ray flaw detector for industrial use was recently manufactured at the Tantung Tool Plant in Liaoning Province. This X-ray flaw detector for industrial use can detect flaws such as cracks, foreign elements, and air holes, in steel plate of a thickness of 60 mm., correctly determining their location and size. The quality situation inside of magnesium, aluminum, and other light metals as well as plastics, rubber, and other non-metallic materials, can be clearly inspected with this machine.

Heretofore, the greater part of China's flaw detectors for industrial use have been imported. During the last few years, China has begun production of several X-ray flaw detectors for industrial use, but the number of models was small, their penetration capability relatively low, their continuous period of use short, and they could not fulfill production requirements.

This X-ray flaw detector for industrial use which was recently successfully trial-manufactured has high voltage, large electric current, the depth of penetration is three times greater than X-ray flaw detectors previously produced domestically for industrial use, and since the length of time it can be continuously used has increased five times, its sphere of application has been expanded and it has come to more excellently fill needs of industrial sectors such as aviation, machinery, electricity, the chemical industry, and plastics and food products. As a result of strict inspection by specialists, it was recognized that efficiency of penetration, sensitivity, and the full-load continuous operation condition of this X-ray flaw detector for industrial use, as well as acuteness of the various control mechanisms, all meet standards of design requirements (New China News Agency, 21 September 1965).

Supersonic Thickness Measurer

A new-model thickness measurer created by Chinese technicians recently entered into quantity production at the Shanghai Chungyuan Electrical Machinery Plant. This thickness measurer which is called a supersonic pulse-type transistor thickness measurer can accurately measure the degree of corrosion as well as excess thickness of such things as various kinds of metal slabs, pipe, boilers, and high-pressure containers while in use, and is convenient for disassembled repair. This precision measuring device is necessary in all industrial branches such as shipbuilding, aviation, petroleum, and chemical. By scientific inspection, it was determined that its structure as well as performance were both very advanced, and it is used at present in such branches as ship repair and the petroleum and chemical industries, and is producing very good results. This thickness measurer is only about the size of an ordinary aluminum lunch box, and with one short cable attached, the total weight is only 1.6 kilograms. The measuring device is carried in one hand, and in one hand is held at one end of the cable what is called a switchboard, which is a metal capsule the size of a thumb, and when the steel plate of the ship's hull under repair is

lightly passed over, the indicator of the measuring device immediately shows on the graduated scale the thickness of the steel plate at that place. When only a few individual locations of the steel plate are passed over with this measuring device, the status of corrosion of the steel plate during navigation as well as whether there is any necessity for replacing it, can be quickly determined. Its sensitivity can even measure small holes and foreign elements in steel material. In maintenance and repair of ships, it is necessary to measure the thickness of many structural items, and in the past, thickness of steel plate was measured by making a hole in the ship's hull, welding the hole closed after measurement. In measurement of 5,000-ton ships, from 500 to 1,000 holes had to be made, and the expense reached many thousands of yuan. Not only was labor and expense involved, but the time for the ship was long, and it also affected the life of the steel plate of the ship's hull. If this thickness measurer, which utilizes a semi-conductor, is used, such problems are solved (New China News Agency, 26 October 1964, 26 April 1965).

Supersonic Rail Flaw Detector

At the Shant'ou Supersonic Electronic Equipment Plant in Kwangtung Province, the CTS-4 model rail air-pressure welding supersonic flaw detector is being produced in small quantity. This measuring instrument seeks out and measures flaws in rail air-pressure welding, and its frequency is higher and sensitivity better than ordinary supersonic flaw detectors which are manufactured in China. Using a frequency of 2.5 megacycles, it can seek out and measure flaws of more than 0.3 mm. at a depth of 200 mm., whereas ordinary flaw detectors can only seek out and measure flaws of more than 1 mm. at a depth of 200 mm. The Shant'ou Supersonic Electronic Equipment Plant is a small plant with only about 100 employees, but in the past two years, it has successfully trial-manufactured new products not produced very much at other plants in China, such as supersonic diagnosis instruments, supersonic head and brain diagnosis instruments, and supersonic flaw detectors. This new rail air-pressure welding supersonic flaw detector became necessary as the railroad branch adopted new technology, and it was successfully trial-manufactured having been commissioned by the Railroad Department (New China News Agency, 21 September 1965).

Also, the Wuhan Electronic Measuring Instruments Plant recently designed a handy transistor supersonic rail flaw detector. This measuring instrument has a weight of only four kilograms, and its volume is also small, and when operating, it is not necessary to carry it on the back, it being convenient to carry, and the performance of the measuring instrument is quite good and it can investigate not only longitudinal flaws inside the rail, but also lateral ones (Jenmin Jihpao, 27 August 1965).

Precision Micro-Scale

A precision micro-scale which has a minimum weight sensitivity

of 1/1,000,000 gram and a maximum weight capacity of 2 grams was recently manufactured at the Shanghai Scales Plant. The weights of this precision micro-scale are smaller than a crystal of white sugar. Its sensitivity is very keen, and when a person brings his hand near, the change in weight of an object produced by the person's body temperature can be felt by the scale. Thus, the scale is placed in a room with constant temperature, and isolated equipment is attached on the outside. The item to be weighed and the weights used are both sent in through two windows by means of a revolving tray of the scale. The window is always closed, and the opening and shutting is done completely from the outside.

This precision micro-scale is used in measurement of first-class weights in state weight measurement inspection organs, and it is also necessary when measuring mass of matter in laboratories and test-rooms in scientific research units and universities and specialized schools.

The Shanghai Scales Plant in 1960 manufactured a micro-scale with a weight sensitivity of 1/200,000 gram, and subsequently at the beginning of 1963, undertook the task of trial-manufacturing a precision micro-scale with a weight sensitivity of 1/1,000,000 gram, and at the end of 1964 it was successfully trial-manufactured. According to related data, in foreign countries, copper and aluminum are used as material for weight levers, but the design personnel of the same plant have made levers using a more ideal material. The weight of this material is comparatively light, its mechanical strength high, and the effect of heat is comparatively small. When the manufactured article weighs matter, the error is one graduation (1/1,000,000 gram), and this index attains a quite advanced level internationally (New China News Agency, 17 October 1965).

The same kind of precision micro-scale is also being manufactured at Peking.

In addition, as related to scales, the Shanghai Tungfang Scales Plant has this year successfully manufactured 13 kinds of high-grade scales. These scales are all urgently needed in Chinese industry and agriculture and in communication and transportation undertakings, and included in them are important new products manufactured for the first time in China. Among these new products are measuring instruments for tensile strength, traction strength, and pressure, for example, the "chain strength measurer" and the "traction strength measurer," and these are used in measuring the tractive strength of airplanes, trains, automobiles, ships, and tractors. In addition, there are various kinds of scales for specialized use. For example, the "photoelectric controlled automatic material mixing scale" is used in large-sized automated enterprises, and it can automatically feed, weigh, and select materials, and since it is photoelectrically controlled, workers can operate it from afar (New China News Agency, 20 October 1965).

The Shanghai Dynamometer Plant this year manufactured three kinds of high-precision, large weight standard scales with a loading capacity of 1, 5, and 20 kilograms. These standard scales are pre-

cision scales necessary in industrial and mining enterprises, scientific research branches, and in laboratories of universities and specialized schools, and their graduated values are respectively 0.5 mg., 2.5 mg., and 10 mg., their precision at full scale all being 1/2,000,000 (New China News Agency, 16 April 1965).

New-Model Carbon Measuring Device

A mechanical process controlled automatic carbon measuring device which can quickly and accurately analyse the amount of carbon in such materials as various kinds of steel, pig iron, and cast iron, has been successfully trial-manufactured at the Shenyang No. 1 Machine Tool Plant. It is said that this carbon measuring device has a structure which is advanced over imported carbon measuring devices, and also that its efficiency is superior. In chemical analyses with this, the test piece is put in a tube furnace and oxidized, and then it is only necessary to turn on a switch, and the machine automatically conducts the chemical examination in a processing manner, and in a mere three minutes, the results of the examination are automatically and accurately shown on the graduated scale of the carbon measuring device (New China News Agency, 13 September 1965).

New-Model Magnetometer

The Peking Geological Equipment Plant recently manufactured a transistor nuclear propelled type magnetometer for use in prospecting. On the basis of experimental use in field investigations, its discernment capability is much better than that of foreign products of the same kind, and moreover, its volume is small and its weight light, and geological survey personnel report that it has been demonstrated to be very suitable for investigating mineral deposits of weak magnetism in hilly and mountainous regions, and small-quantity production of it has already begun (New China News Agency, 21 September 1965).

Model 62A Solar Telescope

The model 62A solar telescope used for study of physical phenomena of the sun has been successfully trial-manufactured by cooperation of the Chinese Academy of Sciences, the Shanghai Scientific Instruments Plant, the Nanking Astronomical Instruments Plant, as well as related units. This model 62A solar telescope is an astronomical optical machine which has photoelectric induction semi-automatically controlled equipment. When a high dispersion and diffraction lattice spectroscope is attached to the telescope, the spectrum of the sun can be studied with photographs or optical methods, and physical processes of solar surface activity, for example explosion of flares, can be investigated. The precision and sensitivity of this solar telescope are quite high, and when it is turned to the limit position, protection equipment on the machine automatically cuts off the power source and sets off an alarm. In addition to the fact that the exposure time of

spectrum photography can be manually controlled, it can also be controlled by automatic timing. This solar telescope has already been delivered to the Peking Astronomical Observatory and is being tested (New China News Agency, 7 April 1965).

Electronic Clock Corrector

The Nanking Tzuchinshan Clock Plant in 1964 successfully trial-manufactured an electronic clock corrector and this year began small-quantity production and is advancing preparation for supplying it to clock plants, scientific research units, and universities and specialized schools. When measuring with this corrector, it is learned whether or not the running of the clock is normal in only one or two minutes. When using this electronic clock corrector and comparing a standard frequency of very high precision with the frequency of the clock (striking of seconds), the operational status of the clock is automatically recorded by dots on paper. Subsequently, when the inclination of the recorded line is reflected on a number reading panel, the momentary error and night and day error of the clock are immediately read. This electronic clock corrector can correct the momentary error and night and day error of various kinds of clock equipment. Previously, it was not possible to manufacture the electronic clock corrector in China, and comparatively few had been imported (Jenmin Jihpao, 6 June 1965).

High-Temperature Water Surface Meter

A high-temperature water surface meter which could not previously be manufactured in China has been successfully manufactured at the Taiyuan Chungyuan Glass Plant. This is also called a fluid surface glass plate, and it can withstand the high temperature of 400 degrees centigrade and is used in observing water surfaces and oil in industrial branches such as petroleum, chemical, and electric power, and in communication and transportation branches, and quantity production has already begun and it has begun to be supplied to many regions in the country (New China News Agency, 19 August 1965).

Food Provisions Moisture Measuring Device

A portable measuring device used for measuring moisture of food provisions has been successfully trial-manufactured by the Wuhan Telegraph Plant. This is called an electric capacity type food provisions moisture measuring device, and is a measuring device which cannot be lacking in food provisions purchasing, storage, and processing branches, and it has many points which are superior as compared with the heretofore widely used in China electric resistance type food provisions moisture measuring device. That is to say, its volume is small, the weight is light, and it is convenient to carry, and moreover, since it uses flashlight batteries as a power source, it can also be used in places where electricity is not supplied. The operation is also very simple, and when the food device is pressed into the container and the power source connected,

the correct moisture content is learned from the meter needle (New China News Agency, 24 September 1965).

Measuring Instruments for Paper-Making Plants

Paper thickness meters, tearing strength measuring devices, paper air permeability measuring devices, and paper pulp rupturability measuring devices, which are considered urgently necessary in measuring quality of products in the paper-making industry, and especially in medium and small-sized paper-making plants, have been successfully trial-manufactured at the Changch'un Non-Metallic Materials Testing Equipment Plant. As a result of inspection, these four measuring instruments conformed to design requirements and the performance was comparatively good, and small-quantity production has begun (New China News Agency, 21 July 1965).

Electromagnetic Oscillation Tester

A measuring device used in measurement tests of the oscillation resistance capacity of various kinds of machines, electrical machinery products, parts, measuring instruments, and meters -- the electromagnetic oscillation tester, was successfully trial-manufactured at the Suchou Testing Equipment Plant and has already entered into quantity production. Domestically-produced materials were used completely in this electromagnetic oscillation tester.

Radio Altimeter and Radio Orientation Meter

The Chinese Academy of Sciences Surveying and Geophysics Research Institute has manufactured a radio altimeter used in aerial surveying and a radio orientation meter which determines the position of airplanes and ships. The performance of these two measuring devices is good, and they are not affected by poor vision or weather or by complexity of topography. In aerial photography, land surface altitude and object positions which are simultanesouly measured by these two measuring devices can be automatically recorded (New China News Agency, 10 August 1965).

Titanium Diffusion Pump

A titanium vaporization pump (titanium diffusion pump) which was trial-manufactured with the cooperation of the Chinese Academy of Sciences Scientific Instruments Plant and the Chinghua University radio telegraph and electronic departments, is important equipment of the large-sized electronic tube which makes high vacuums, and can produce a vacuum of up to 10^{-9} mHg, and the several which have at present been trial-manufactured have already begun to be used, and quantity production will soon be conducted (Kuangming Jihpao, 29 August 1965).

Bearing Measuring Device

China's first bearing measuring instruments plant -- the Yentai Bearing Equipment Plant, was formerly the Yentai Measuring Instruments and Cutting Tools Plant, and could only manufacture such products as drills and dies, but with the policy of self-salvation it developed from small to large and has until now manufactured more than 40 kinds of bearing measuring devices for various uses, supplying them to various bearing plants and related branches in the country, and has played a great role in promoting development of China's bearing industry (New China News Agency, 19 September 1965).

Also, in the manufacture of such things as high-grade precision machine measuring devices and wrist watches, various micro-drills are necessary, and China has heretofore depended on importation of these, but Engineer Chu Fu-lin, a worker at the Shanghai Tool Plant, in order to meet demands of development of China's precision machine and measuring devices industry, and overcoming various difficulties in cooperation with other workers under a very crude situation of equipment conditions, successfully trial-manufactured various kinds of micro-drills one after the other, and at present, quantity production of these drills is becoming possible in the same plant's small-sized cutting tool department (New China News Agency, 16 June 1965).

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